CHAPTER 18: BOILER WATER CONTROL Part 1

This chapter will cover boiler water control (its chemical treatment), including basic water analysis.

It is advisable to use a color code to distinguish the different reagents we will use, which reduces the risk of human error. In addition, the solutions should be labeled.

All analyses are based on an indicator that shows the color change of the solution being measured (i.e., the point at which a substance (titrant) must be added to measure the parameter.

The amount of titrant consumed to reach this color change is called titration).

We can use plastic syringes to measure the amount of titrant solution, adding it drop by drop while swirling the sample (in an Erlenmeyer flask) to a quantity appropriate for the expected concentration.

When we say N/10 (normality 10) of a solution, it refers to the molecular concentration of a substance in the solution.

For example, if we say "Normal Solution" of sulfuric acid, it means that the weight of the sulfuric acid molecule in grams is dissolved in 1 liter of distilled water.

Always add acids to water, not the other way around, as a hot reaction can occur that may splash and cause burns (a chemical attack on the skin; the most dangerous risks are not protecting the eyes and inhaling the released gases).

Therefore, when we say N/10 or "normal tenth," it means one-tenth of the molecular weight in grams dissolved in distilled water to 1 liter.

COLOR CODE:

1-Red.....Phenolphthalein Alkalinity

2-Gray....Total Alkalinity

3-Black...Chlorides

4-Blue.....Total Hardness

5-Yellow.....Phosphates

6-Green.....Sulfites

7-pH

8-Salinometer.

The product names for each code are found in the detailed analysis report. This color coding is personal in my case (C.W.T.).

The factor by which the titrant consumption must be multiplied to determine the amount of the element being measured depends on the sample size and the normality of the titrant.

For example, the factors listed below are for
Sulfuric Acid N/10 (Red and Gray alkalis),
ETDA N/50 Total Hardness Sequestrant (Blue),
and Silver Nitrate N/10 for chlorides (Black):

TABLE OF FACTORS BY SAMPLE VOLUME:

Sample Quantity	RED	GRAY	BLUE	BLACK
100 ml	ml.x50	ml.x50	ml.x10	ml.x35.5
50 ml	ml.x100	ml.x100	ml.x20	ml.x71
25 ml	ml.x200	ml.x200	ml.x40	ml.x142
Results:	**ppm CaCO3**	**ppm CaCO3**	**ppm CaCO3**	**ppm Cl-**

1_RED....PHENOLPHTHALEIN ALKALINITY (color change approximately at pH 8.3-8.4):

Take the sample, let it cool, and measure (100 ml, 50 ml, or 25 ml).

Add a few drops of phenolphthalein (red dropper). If there is no red color change, the analysis is complete, and the result will be zero.

If there is a red color change, using the (red) syringe, draw 5 ml of N/10 sulfuric acid from the (red) bottle and add it drop by drop (while continuously stirring) until the red color disappears and the water returns to its initial color.

The reading in ml of acid used, multiplied by the corresponding FACTOR, gives the Phenolphthalein Alkalinity in ppm as CaCO3.

Do not discard the sample and continue using the (red) syringe with the remaining acid.

2_GRAY....TOTAL ALKALINITY (color change at pH 4.3):

Continuing with the previous sample, add a few drops of Methyl Orange (gray dropper).

The agitated sample will turn a pale yellow color.

If it turns pink (salmon red), the analysis is complete, and the reading will be the same as the Phenolphthalein Alkalinity.

In the first case, a yellow color, continue adding the acid from the syringe (red) or refill it if all the acid has been used, drop by drop, while continuously agitating until the pink color appears.

The reading of the ml used will be from the beginning of the Phenolphthalein Alkalinity measurement.

Multiplying the ml reading by the corresponding FACTOR will give the Total Alkalinity result expressed in ppm as CaCO3.

Do not discard the sample; continue with Chlorides.

The hydroxide alkalinity ("free soda") is calculated by multiplying the phenolphthalein alkalinity by 2 and subtracting the total alkalinity (= Hydroxide Alkalinity).

This allows you to see the amount of "free soda" in the boiler water.

At low pressure (up to 10 kg/cm², 142 PSI), it is advisable that the "free soda" be less than 450 ppm as $CaCO_3$ (Sodium Carbonate), since at higher values, foaming occurs (which causes boiler water carryover in the steam and also increases the possibility of "caustic embrittlement" in areas of high vaporization).

As boilers operate at higher pressures, the "free soda" content must be reduced until it reaches a negative value (starting at 40 Kg/cm2), lowering it to levels where there is a lack of free soda so that the pH is below the Trisodium Phosphate curve (to reduce the possibility of localized soda attack on high vaporization surfaces).

3_BLACK.....CHLORIDES (Mhor method):

With the previous sample, add a few drops of Potassium Chromate until the sample turns yellow (black dropper).

Using the syringe (black), take N/10 Silver Nitrate (black bottle) and add it drop by drop (while continuously stirring) until a permanent brick-red color appears.

The reading of the ml of N/10 Silver Nitrate used multiplied by the corresponding FACTOR gives the result in ppm as Chloride ion (Cl–).

If alkalinity has not been determined for the sample, add a few drops of Phenolphthalein (red dropper) and then add N/10 Sulfuric Acid until the red color disappears.

If the sample contains sulfites (more than 60 ppm SO3–), to avoid interference, it should be converted to sulfates.

To do this, add a few drops of Hydrogen Peroxide (oxygenated water) to a new sample or leave the sample in contact with the atmosphere for several hours.

4_BLUE...TOTAL HARDNESS:

Take a fresh sample, add 10 to 20 drops of ammonia solution (blue dropper), shake, and add a pinch of hardness indicator (blue container, black powder based on Eriochrome Black T and a buffer).
Shake.

If it turns a clear blue color, there is no hardness. If the solution turns a wine-colored hue, it indicates hardness, which we will measure:

- Using the syringe (blue), take a small amount of EDTA from the blue bottle (EDTA is a hardness sequestrant calibrated to a value equivalent to N/50; EDTA is the abbreviation for ethylenediaminetetraacetic acid, plus a pinch of magnesium hydroxide so that it can change color in water that does not contain magnesium, since it is the presence of magnesium that allows it to change color at the end of the analysis) and add it drop by drop slowly (with continuous stirring) until a clear blue color appears.

The reading in ml of EDTA used multiplied by the corresponding FACTOR gives the TOTAL HARDNESS in ppm as CaCO3.

In cases of cloudy boiler water (with probable iron interference) or very high alkalinity, it is advisable to dilute the sample in 5 or 10 dilutions, then multiply the result by the number of dilutions.

The water used for dilutions must be deionized or distilled (test for hardness beforehand). Analysis is not necessary for boiler water with excess phosphates.

5_YELLOW...PHOSPHATES using a Molybdate and Metavanadate-based indicator:

Using a funnel with filter paper (if the water is cloudy), fill it with the water to be analyzed.

Place the funnel's spout into the 10 ml clear plastic tube (fill it once for rinsing and discard the excess). Refill the tube to the upper (10 ml) or lower (5 ml) mark.

Add 8 drops of indicator (yellow dropper) or 4 drops if using the lower mark.

Cap the tube, shake, and let it stand for 5 minutes. Compare the resulting yellow color.

This will be the result in ppm, read on the comparator as ppm of PO4-3 (phosphate).

The reagent used can be based on **Ammonium Molybdate and Metavanadate, sulfuric acid, and distilled water, producing a yellow color reaction with phosphate** (which can be compared visually or with a comparator) colorimeter.

Its advantage is that it has little interference (especially with silica).

6. GREEN.....SULFITES: Using dipsticks (imported: Merck® or another brand) that will measure semi-quantitatively.

Use a sample of non-aerated water. Immerse the dipstick (indicator part) for a few seconds (5 to 10 seconds), let it drain for a few seconds, and after 30 seconds (no longer), compare with the color scale.

The reading will be ppm of SO3-2

7. pH: Using pH 0-14 dipsticks (imported, such as Merck®).

In a clean container rinsed with the same water, place a cold sample of non-aerated boiler water (10 to 50 ml).

Immerse the pH indicator dipstick (it must be capable of indicating between pH 8 and 13) for a few seconds (5 to 10 seconds) and then immediately compare with the colors on the comparator.

8-TOTAL DISSOLVED SALTS (T.S.D.) Using conductivity meters for boiler water, in µS/cm or ppm

Remember that boiler water does not respond to a conductivity equivalent to a standard laboratory solution, but rather to waters with varying salt content.

This is true when calibrated for ppm (parts per million), the most commonly used standard solution being that 2.35 grams of sodium chloride per liter is

equivalent to 3,000 ppm (3,000 ppm can be said to be equivalent to 4,500 µS/cm).

Generally, the temperature compensation of these meters is automatic at 25ºC (77°F); otherwise, it will give an erroneous value if not corrected, since the reading increases as the sample temperature rises.

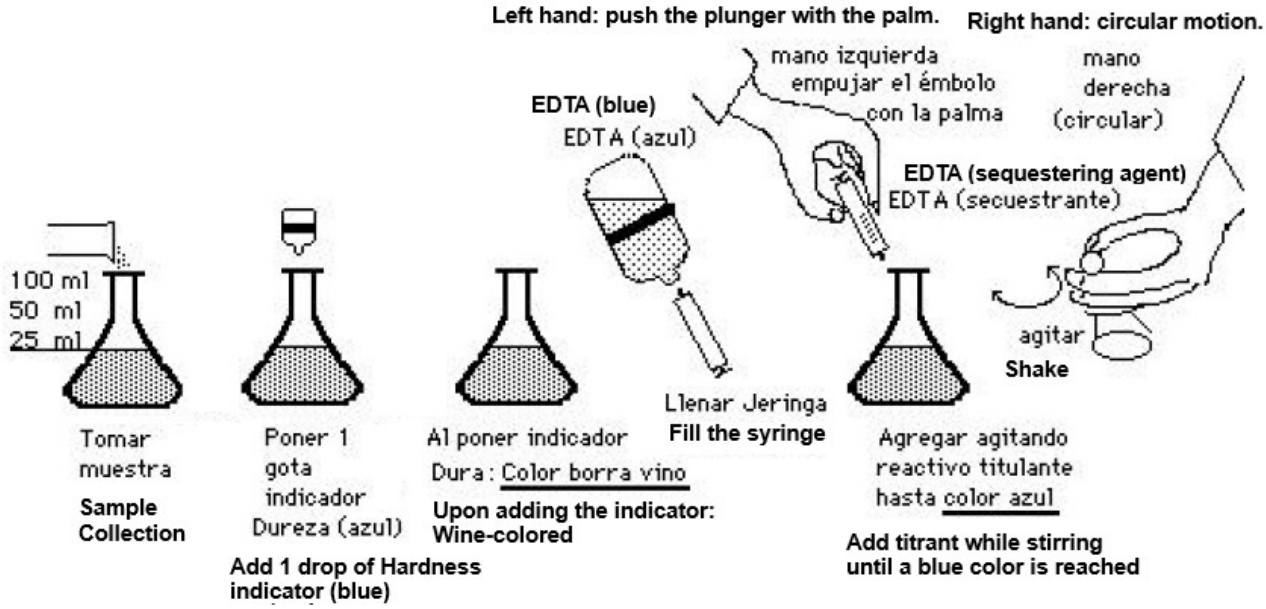
Previously, manual correction was performed by measuring the sample temperature and subtracting or adding, depending on the temperature, to the value given by the conductivity meter (manual correction).

In the case of gravity meters, temperature correction is also necessary, since the density of water varies with its temperature: Cool the sample in the same way as in the previous analyses.

Follow the instructions for the meter being used, whether it is a conductivity or gravity meter.

TOTAL HARDNESS METER

Total hardness in water represents the calcium and magnesium salts, expressed in ppm (parts per million) as calcium carbonate (CaCO3).



As we see in the diagram above, the procedure for measuring the total hardness of water is as follows:

This procedure is applied to all measurements: first, an indicator (generally a few drops) that changes color at the end of the titration (Eriochrome Black in Triethanolamine or Eriochrome Black with a few drops of ammonia added beforehand to raise the pH).

Then, using a calibrated 5 ml plastic syringe (for example), we add the titrant (EDTA, the element that is measured according to its quantity, concentration, and sample size) drop by drop until the color change occurs.

Using the amount of titrant in milliliters, multiply by a factor that depends on the concentration of the titrant.

Normality, that is, the fraction of the molecular weight in grams dissolved in a 1-liter solution of distilled water; if we say N/10 or normal 10, it is the molecular weight of the titrant divided by 10 and dissolved in the solution with distilled water up to 1 liter.

The other factor that determines the factor is the amount of sample taken for analysis; the smaller the sample, the higher the calculation factor.

See the table at the beginning of this chapter.

It is very important that the water is clear; otherwise, filter it with filter paper.

When measuring phosphates, pH, and sulfites, the guide is the color that develops in the test tube containing the sample or on the filter paper immersed in the sample.

Firewood adapted boilers

LAS CALDERAS ADAPTADAS A LEÑA (EUCALIPTOS).

CARLOS W. THOMASSET

Locomotora a leña "CORAZON DE FUEGO"

Caldera de 4.000 Kg hora (carbón)
Un pase (hogar y tubos). Tiro inducido
Quemando leña (eucaliptos) en astillones, baja la producción casi un 50%.
Si quemara F. Oil, también tendría problemas de combustión: humos, gases no quemados.....